PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 12397560JCC	**FOR FURTHER ACTION**	See Form PCT/IPEA/416
International application No. **PCT/AU2004/000055**	International filing date *(day/month/year)* 15 January 2004	Priority date *(day/month/year)* 15 January 2003
International Patent Classification (IPC) or national classification and IPC **Int. Cl.** [7] C04B 38/02, 22/04		
Applicant COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANISATION et al		

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 7 sheets, including this cover sheet.
3. This report is also accompanied by ANNEXES, comprising:
   a. [X] *(sent to the applicant and to the International Bureau)* a total of 7 sheets, as follows:
      - [ ] sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
      - [ ] sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.

   b. [ ] *(sent to the International Bureau only)* a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or table related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).
4. This report contains indications relating to the following items:
   - [X] Box No. I Basis of the report
   - [ ] Box No. II Priority
   - [ ] Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - [ ] Box No. IV Lack of unity of invention
   - [X] Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - [X] Box No. VI Certain documents cited
   - [ ] Box No. VII Certain defects in the international application
   - [X] Box No. VIII Certain observations on the international application

Date of submission of the demand 3 June 2004	Date of completion of the report 12 April 2005
Name and mailing address of the IPEA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. (02) 6285 3929	Authorized Officer **WARREN TAYLOR** Telephone No. (02) 6283 2229

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/AU2004/000055

Box No. I Basis of the report

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.

☐ This report is based on translations from the original language into the following language , which is the language of a translation furnished for the purposes of:

☐ international search (under Rules 12.3 and 23.1 (b))

☐ publication of the international application (under Rule 12.4)

☐ international preliminary examination (under Rules 55.2 and/or 55.3)

2. With regard to the **elements** of the international application, this report is based on (*replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report*):

☐ the international application as originally filed/furnished

☒ the description:

pages **1, 3 - 23** as originally filed/furnished
pages* **2A** received by this Authority on **22 December 2004** with the letter of **22 December 2004**
pages* **2** received by this Authority on **11 March 2005** with the letter of **11 March 2005**

☒ the claims:

pages as originally filed/furnished
pages* as amended (together with any statement) under Article 19
pages* **25-28** received by this Authority on **22 December 2004** with the letter of **22 December 2004**
pages* **24** received by this Authority on **11 March 2005** with the letter of **11 March 2005**

☒ the drawings:

pages **1/1** as originally filed/furnished
pages* received by this Authority on with the letter of
pages* received by this Authority on with the letter of

☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing.

3. ☐ The amendments have resulted in the cancellation of:

☐ the description, pages
☐ the claims, Nos.
☐ the drawings, sheets/figs
☐ the sequence listing (*specify*):
☐ any table(s) related to the sequence listing (*specify*):

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

☐ the description, pages
☐ the claims, Nos.
☐ the drawings, sheets/figs
☐ the sequence listing (*specify*):
☐ any table(s) related to the sequence listing (*specify*):

* *If item 4 applies, some or all of those sheets may be marked "superseded."*

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/AU2004/000055

Box No. V **Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Claims	1-29 & 31	YES
	Claims	30	NO
Inventive step (IS)	Claims	1-29 & 31	YES
	Claims	30	NO
Industrial applicability (IA)	Claims	1-31	YES
	Claims		NO

2. Citations and explanations (Rule 70.7)

The current application is directed to light weight, cellular cementitious products having a density/porosity gradient that improves the strength to density ratio of the finished product and process to produce the same.

The problem to solve appears to reside in providing a method of manufacturing a cementitious product having enhanced compressive strength and densities similar to cellular concrete that are suitable for thermal insulation and sound absorption.

The following documents appear relevant to the present invention;

D1 - US 5775047

D2 - JP 07-138084

D3 - JP 2002-326882

D1 discloses cementitious structural members and methods to prepare them. Said structural members are prepared from a viscous, mouldable, cementitious slurry that includes cement binder, air bubbles (giving the slurry a viscosity sufficient to prevent bubbles coalescing into larger bubbles) and a foaming agent (Col 2).

D2 discloses substantially the same features as the current application claims however this document is directed to production of moulded light weight ceramic compacts. That is, the ceramic compacts comprise a porosity volume ranging from 30-90% (created from a foamed liquid) and a dense layer that is 5-55 microns from the surface of said compacts. The abstract further contends the porosity continuously increases from the dense layer to the central region of the compact (ie a density/ porosity gradient is achieved). The compact has a high strength to density ratio.

Neither of D1 or D2 directly disclose a feature of shaping the premix in a formwork having a lid attached thereto in order to (1) restrain the premix from rising or (2) allow the collapsing of an expanding premix when contacting the lid, thereby formulating the proposed density/porosity gradient within said porous cementitious product. Consequently, the subject matter of the proposed claims appears novel in light of D1 & D2.

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/AU2004/000055

Box No. VI Certain documents cited

1. Certain published documents (Rule 70.10)

Application No. Patent No.	Publication date *(day/month/year)*	Filing date *(day/month/year)*	Priority date (valid claim) *(day/month/year)*
WO 2003/022776 A	20 March 2003	15 January 2004	15 January 2003

WO '776 discloses the preparation of cementitious compositions having enhanced sound-absorbing properties as well as being fire-proof. The composition is manufactured into an open-pored construction material.

The composition comprises water, a cement mixture, a pore-forming agent and an aggregate material (which already has air pores within its structure) - page 1 (L23-29). The pore-forming material is an Al powder that reacts with the cement mix to produce gas bubbles in the premix, ultimately providing a dry density of 200-1000kg/m^3 (p2, L17) and a porosity/density gradient through the size and number of pores produced (p5, L4-5 and claim 1). It should also be noted at p8 (L21-25) it is disclosed the pores (size and number) can be adjusted to change the density/porosity of said cementitious composition. It is considered present claims 1-4, 8-9, 13-14, 16-18, 27-29 & 31-34 are anticipated by this document, however the document has a publication date later than the earliest priority date of the present application.

2. Non-written disclosures (Rule 70.9)

Kind of non-written disclosure	Date of non-written disclosure *(day/month/year)*	Date of written disclosure referring to non-written disclosure *(day/month/year)*

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of: Box V

D3 discloses autoclaved light weight concrete having substantially the same density and compressive strength values afforded the current application. D3 further discloses an improvement in the strength to density ratio of the light weight concrete that coincides with a differential pore distribution of voids throughout said concrete. The pores are generated by a frothing agent within the concrete premix and their distribution throughout the premix is calculated from the volume percent of pores in the slurry (ie a difference in pore sizes and pore numbers). It is considered this calculation implies a porosity gradient, however it is not disclosed whether this gradient increases from the outer region to the central region or vice versa. It is further noted the document discusses the improvement in strength to density ratio is due to the differential pore distribution.

NOVELTY (N) Claim 30

Proposed claims 1-29 and 31 define a method of manufacturing a porous cementitious product from a cementitious premix subjected to casting, 'aeration' (bubble generation within the premix) and curing the premix within a formwork having a lid. The 'aeration' creates a density or porosity gradient that either shows an increase in density from the centre region to the outer region or conversely an increase in porosity from the outer region to the centre region of said cementitious product via the lid of said formwork being capable of; (1) restraining the premix from rising or (2) allowing the collapse of the expanding premix when contacting the lid. The subject matter of proposed claims 1-29 & 31 are not found in documents D1-D3 and is therefore afforded novelty and an inventive step. D1 and D2 also do not deprive proposed claim 30 of novelty.

Proposed claim 30 merely defines a porous cementitious product comprised of a relatively low density core and high density outer regions and having a set of desired physical properties. Because the porosity profile defined therein does not necessarily have to be formed by generating gas bubbles within the cementitious product as defined in proposed claim 1, it is not clear whether the product prescribed by proposed claim 30 is different from the product disclosed in D3. The applicant's submissions to D3 not disclosing a *"spatial distribution of porosity.."* is not readily understood since it is not clear where this feature manifests itself in proposed claim 30 nor is their further contention that the porosity profile of proposed claim 30 would produce a cementitious material different to that of the material disclosed in D3. The light weight cellular concrete (LWCC) of D3 has within it's premix, gas bubbles - generated by a foaming agent – which are not uniform in size or distribution thereby forming a porosity gradient. Whilst there is little indication in D3 in which direction this porosity gradient evolves, the strength to density ratio and the density and compressive strength values of the currently proposed invention are substantially similar to those of D3. Hence it is more than reasonable to assume, given these factors, that the same desired physical properties espoused by the applicant in proposed claim 30 would be evident from the LWCC of D3 which would indicate a similar porosity gradient of both cements exist. The applicant's argument that it 'doubts' the LWCC of D3 would exhibit properties commensurate of the currently proposed concrete products appears ineffective in light of a lack of evidence to the contrary. Therefore, in view of the comments made in Box VIII of this opinion and given the concrete of D3 being substantially the same density and compressive strength values of the currently proposed invention, from which it can be expected would produce the desired physical properties outlined in proposed claim 30, it is considered that D3 anticipates claim 30 of the currently proposed application.

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of: Box V

INVENTIVE STEP (IS) Claim 30

Accordingly since the disclosure of D3 anticipates the features contained in proposed claim 30 it is considered this claim also lacks an inventive step in light of D3.

Neither disclosure of D1 or D2 individually contain all the features deemed material to the present invention, nor each in combination with D3 appear to anticipate the features contained in at least claims 1-29 & 31of the present invention. Accordingly currently proposed claims 1-29 & 31 are afforded an inventive step over D1-D3.

Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

1. Proposed claim 30 does not appear to be fully supported by the current description because there is no indication in claim 30 that the porosity profile defined therein is the result of gas bubbles generated in the cementitious premix, which is categorically stipulated in the description (eg, p2, L23 - p3, L1) as being highly relevant in producing light weight concrete materials with improved compressive strength. Furthermore the applicant in his response (11 March 2005) clearly indicates the gas bubble generation in the cementitious premix is integral to the material working of the present invention defined in proposed claim 1. Accordingly, this aspect should be reflected in **each** of the independent claims.
2. Additionally proposed claim 30 merely prescribes a porous cementitious product defined by a set of desired physical properties rather than any specific technical feature to achieve those properties. As a result it is not clear; (1) what features impart such properties to said cementitious product or (2) how these features are imparted, especially when a feature deemed essential to the material working of the present invention cementitious premix (notably gas bubble generation within said premix) is absent from proposed claim 30.

In accordance with the invention it is possible to vary the density of a given premix by varying the volume and distribution of gas bubbles present in the final product. This makes it possible to manufacture products with varying strength to density ratios from a

introduction of low density voids or bubbles into the cementitious mixture, and the resultant products are usually referred to as "cellular" concretes. These typically have densities in the range of 500 to 1000 kg/m^3 but their compressive strengths are seldom in excess of 5 MPa. Consequently, they are often unsuitable for load bearing applications. Indeed, one of the main applications for such products is for thermal insulation. It would be desirable to provide cementitious products with similar densities but with enhanced compressive strength. Furthermore, in order to promote enhanced hardening, some cellular concretes are typically prepared using high pressure autoclaves. The equipment costs involved are very high, and it would be desirable to provide an alternative means for preparing suitably low density cementitious products using relatively simple and less expensive techniques.

The present invention seeks to provide a method of manufacturing a cementitious product which satisfies the aforementioned needs and overcomes the disadvantages associated with the prior art techniques described.

Accordingly, the present invention provides a method of manufacturing a porous cementitious product, which method comprises:

forming a cementitious premix;

casting the premix in a desired configuration;

generating gas bubbles within the premix; and

curing the premix,

wherein the gas bubbles are generated and/or collapsed at specific locations within the premix in order to produce a porosity profile along a cross-section of the product such that the product comprises a relatively low density core region and higher density outer regions, wherein a formwork is used for shaping the premix in the desired configuration, wherein the premix is confined in the formwork in order to contribute to the desired porosity profile, and wherein the formwork has a lid in order to restrain rising of the premix and cause collapsing of expanding premix on contact with the lid.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A method of manufacturing a porous cementitious product, which method comprises:

forming a cementitious premix;

casting the premix in a desired configuration;

generating gas bubbles within the premix; and

curing the premix,

wherein the gas bubbles are generated and/or collapsed at specific locations within the premix in order to produce a porosity profile along a cross-section of the product such that the product comprises a relatively low density core region and higher density outer regions, wherein a formwork is used for shaping the premix in the desired configuration, wherein the premix is confined in the formwork in order to contribute to the desired porosity profile, and wherein the formwork has a lid in order to restrain rising of the premix and cause collapsing of expanding premix on contact with the lid.

2. A method according to claim 1, wherein gas bubbles are generated by incorporation in the premix of a heat-activated gas-generating agent.

3. A method according to claim 1, wherein the lid of the formwork is fabricated in such a way so as to allow gas dissipation when gas bubbles collapse at the premix/lid interface.

4. A method according to claim 1, wherein the upper surface of the premix is subjected to trowelling, screeding and/or rolling in order to cause collapsing of expanding premix.

5. A method according to claim 1, wherein the formwork is vibrated vertically and/or laterally at an appropriate frequency and amplitude in order to achieve an even distribution of premix within the formwork, to control the cross-sectional bubble

distribution and/or to improve the quality of finish of the product surfaces.

6. A method according to claim 4, wherein a formwork is used for shaping the premix and wherein the formwork is vibrated vertically and/or laterally at an appropriate frequency and amplitude in order to achieve an even distribution of premix within the formwork, to control the cross-sectional bubble distribution and/or to improve the quality of finish of the product surfaces.

7. A method according to claim 1, wherein gas bubbles are introduced at selected locations into a cast premix by use of sparging apparatus.

8. A method according to claim 7, wherein the sparging apparatus comprises a sparging lance comprising an elongate hollow member having a series of holes through which gas may be injected into the premix.

9. A method according to claim 8, wherein the lance is moved through the premix during gas injection to provide a distribution of bubbles appropriate to achieve the desired porosity profile.

10. A method according to claim 1, wherein the premix is sufficiently viscous to achieve gas bubble retention but not so highly viscous so as to inhibit bubble formation.

11. A method according to claim 10, wherein the viscosity of the premix is controlled by varying the premix temperature, by blending of fine materials into the premix to obtain desired particle gradation for optimal flow properties and/or by incorporation into the premix of appropriate additives.

12. A method according to claim 11, wherein the viscosity of the premix is controlled by incorporation into the premix of a superplasticiser.

13. A method according to claim 1, wherein the strength to density ratio of the cementitious product is controlled by varying the extent to which the premix is gassed.

14. A method according to claim 1, wherein the strength to density ratio of the cementitious product is controlled by varying the degree of confinement of the premix as it expands due to generation of gas bubbles within the matrix.

15. A method according to claim 1, wherein the strength to density ratio of the cementitious product is controlled by selection based on premix strength.

16. A method according to claim 1, wherein, prior to curing, an upper surface of the cementitious product is finished by cutting, trowelling, screeding or rolling.

17. A method according to claim 1, wherein the cementitious product has a consolidated, dense outer skin.

18. A method according to claim 1, wherein the premix is a high strength premix having a compressive strength of from 60 to 120 MPa (in non-gassed form).

19. A method according to claim 18, wherein the premix is used to manufacture a cementitious product having a dry density of from 1000 to 1500 kg/m^3 and compressive strength of 10 to 25MPa.

20. A method according to claim 18, wherein the cementitious product has a 1-day strength of from 75-90% of its 28-day strength.

21. A method according to claim 18, wherein the product is heat cured at atmospheric pressure.

22. A method according to claim 1, wherein the cementitious product exhibits a

flexural strength of from 3-4 MPa for compressive strengths of from 15-20 MPa for product densities of from 1300-1500 kg/m^3.

23. A method according to claim 1, wherein the cementitious product has a thermal conductivity of from 0.3-0.6 W/m.K for product dry densities of from 900-1300 kg/m^3.

24. A method according to claim 1, wherein high shear mixing is used to vary the premix temperature and/or the premix rheology thereby allowing the viscosity of the premix to be controlled.

25. A method according to claim 18, wherein the cementitious product has a relatively low residual water content.

26. A method according to claim 1, wherein the cementitious product is manufactured in the form of a flat slab, wall panel, roofing tile, block-work system or paver.

27. A method according to claim 1, wherein the formwork includes surface relief in order to produce a patterned surface on the product.

28. A method of manufacturing at least two cementitious products which are formed from a single cementitious premix and which have a different ratio of strength to density, which method comprises forming each cementitious product in accordance with the method claimed in claim 1 and wherein the strength to density ratio of each cementitious product is controlled by varying the degree confinement of the premix as it expands due to generation of gas bubbles within the matrix.

29. A cementitious product obtained by the method as claimed in claim 1.

30. A porous cementitious product having a porosity profile along a cross-section of

the product such that the product comprises a relatively low density core region and higher density outer regions, the higher density outer regions imparting impact resistance, abrasion resistance and resistance to water absorption.

31. Use of a cementitious product obtained by the method claimed in claim 1 in the construction industry as a building material.